Water treatments alone not enough to combat fluorosis in Ethiopia

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Increased intake of dietary calcium may be key to addressing widespread dental health problems faced by millions of rural residents in Ethiopia's remote, poverty-stricken Main Rift Valley, according to a new Duke University-led study.

As many as 8 million people living in the valley are estimated to be at risk of dental and skeletal fluorosis as a result of their long-term exposure to high levels of naturally occurring fluoride in the region's groundwater.

Fluoride is essential for healthy tooth enamel development, but consuming too much of it can damage enamel and bones, particularly in children between the ages of 3 months and 8 years. Mild to moderate fluorosis typically results in permanent discoloring and disfiguration of tooth enamel. Severe fluorosis can cause chronic pain and lead to tooth and bone loss.

Most efforts to combat fluorosis in the region have focused primarily on treating drinking water to reduce its fluoride content.

The new Duke-led study, published online in the journal *Environment International*, finds that these efforts "may not be sufficient on their own, because of the region's geology and the low threshold of exposure at which we found fluorosis was likely to occur," said Avner Vengosh, professor of geochemistry and water quality at Duke's Nicholas School of the Environment.

Increasing the amount of calcium in villagers' diets, or finding alternative sources of drinking water may be necessary in addition to these fluoride-reducing treatments.

By systematically analyzing groundwater quality in the valley, Vengosh and his colleagues found that as water flows from the surrounding mountains into the rift, it interacts with volcanic rock, which contributes fluoride to the water while also removing most of its calcium. That's important, he explained, because "calcium is essential for mineral formation that can capture fluoride in a groundwater system."

Water samples from 48 of 50 wells tested in the valley contained fluoride levels above World Health Organization safe guidelines. The average daily fluoride intake of people drinking from the wells was six times higher than the current no-observed-adverse-effects-level (NOAEL) – the highest known level of exposure that can occur before adverse biological effects are detected.

The researchers also conducted clinical examinations of 200 villagers' teeth to see if differences in fluoride levels in drinking water supplies affected the severity and prevalence of fluorosis in a community's population.

"The idea was to test the hypothesis that higher fluoride in the water correlates to more common and severe cases of fluorosis in the people who drink it. But we found no linear correlation above a certain point," said Tewodros Rango, a postdoctoral researcher at Duke's Nicholas School of the Environment who was lead author of the study. "Essentially, our examinations showed that once you reach a low threshold of fluoride exposure, fluorosis is likely to happen."

In some of the communities, the fluoride levels in well water were so high you could treat the water to cut the fluoride content by half and it

still wouldn't drop below the critical threshold, he said.

In villages where people had access to milk, severe fluorosis was about 10 percent less likely to occur, Rango's clinical examinations found. Further research is needed to explain this anomaly, he said, but it may be possible that by drinking milk -- which is not a common staple in the rural Ethiopian diet -- these people take in enough calcium to retard fluorosis development.

"Future mitigation strategies may want to include increased calcium intake in diets, particularly for children," he said.

The research team's tests also found high levels of naturally occurring toxic elements, including arsenic and uranium, in the groundwater samples.

"The combined impact of these elements on human health may be higher than the sum of the effects from each specific contaminant," said study co-author Dr. Julia Kravchenko, a researcher at the Duke Cancer Institute. "For example, it could result in aggravated toxicity of fluoride as well as increased risk of damaged kidney function. This phenomenon is very important for evaluating region-specific safety limits for water contaminants."

Increased numbers of fluorosis cases have been reported in recent years in many parts of the world, including Mexico, Brazil, China, Vietnam and Thailand. Devising mitigation strategies that take into account each region's geology and water quality is critical, the researchers noted, because global warming could worsen the quality of drinking water in these regions in coming years.

More information:
www.sciencedirect.com/science/article/pii/S0160412012000530

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